

## The first troglomorphic pseudoscorpion of the family Olpiidae (Pseudoscorpiones), with remarks on the composition of the family

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Abstract - A new genus and species of Olpiidae, *Linnacolum linnaci*, is described from a pisolite mesa in the Pilbara region of Western Australia. The sole specimen exhibits troglomorphic facies with highly reduced eyes, pallid colouration and slightly attenuated appendages, differing from all other cave-dwelling olpiids which lack troglomorphic facies. The affinities of the new genus are difficult to determine, but it is most similar to a group of genera characterised by the position of trichobothrium *isb*: *Pseudohorus*, *Austrohorus*, *Xenolpium*, *Euryolpium* and possibly *Heterolpium*. The family Olpiidae is divided into two subfamilies, Olpiinae and Hesperolpiinae.

### INTRODUCTION

Pseudoscorpions of the family Olpiidae are virtually cosmopolitan in distribution, usually occurring in xeric environments under rocks, in leaf litter or beneath the bark of trees. Cave-dwelling olpiids are, however, quite rare, with only five species recorded from subterranean habitats: *Calocheirus tenerifae* Mahnert 2002 from the Canary Islands (Mahnert 2002), and *Progarypus gracilis* Mahnert 2001, *P. liliae* Mahnert 2001, *P. nigrimanus* Mahnert 2001, and *P. setifer* Mahnert 2001 from Brazil (Mahnert 2001). All of these species have large eyes and seem to exhibit no troglomorphic morphological modifications.

Among specimens collected from subterranean habitats within mesas in the Pilbara region of Western Australia was a single male of an unusual olpiid. The specimen has reduced eyes, is slightly pale in colouration, and has slightly attenuate appendages. To further document the subterranean pseudoscorpion fauna of Western Australia we present a description of this species based upon a single male specimen. We also propose a division of the Olpiidae into two subfamilies, Olpiinae and Hesperolpiinae, based primarily upon the length of the venom ducts.

The specimen examined in the present study is lodged in the Western Australian Museum, Perth (WAM). Terminology and mensuration mostly follows Chamberlin (1931), with the exception of the nomenclature of the chelicera (Judson 2007), pedipalps, legs and with some minor modifications to the terminology of the trichobothria (Harvey 1992). In particular, it should be noted that the terminology for the trichobothria used by Harvey (1992) differs slightly from that used by other workers. The setal notation of metatarsus IV follows Muchmore

(1986), who based his system on the observations of Heurtault (1980a, 1980b, 1982) and Heurtault and Rebière (1983).

The specimen was examined with an Olympus BH-2 compound microscope and illustrated with the aid of a drawing tube. Measurements were taken at the highest possible magnification using an ocular graticule. The specimen was examined by preparing a temporary slide mount by immersing the specimen in 20% lactic acid at room temperature for several days, and mounting it on a microscope slide with 10 or 12 mm coverslips supported by small sections of 0.25 mm or 0.50 mm diameter nylon fishing line. After study the specimen were returned to 75% ethanol with the dissected portions placed in 12 x 3 mm glass genitalia microvials (BioQuip Products, Inc.). Images of the whole animal were taken using a Micropublisher 5.0 digital camera mounted on a Leica MZ16 microscope.

### Family Olpiidae Banks 1895

#### Subfamily Olpiinae Banks 1895

#### Remarks

For most of the past 80 years, the Olpiidae were defined by a series of characters states outlined by Chamberlin (1930, 1931) and Beier (1932). Although numerous new genera have been described since the 1930's, the family definition has barely altered. The Olpiidae were recently restricted by Judson (1992, 1993) by the removal of the garypinines to a separate family, Garypinidae, and the removal of the hesperolpiines as a subfamily of Garypinidae. The status of the garypinines as a family was confirmed by Judson (2005), who referred to his unpublished thesis (Judson 1992) in defining the group. With the exclusion of the garypinines from

the family Olpiidae, and the transfer of a further five genera (*Neominniza* Beier 1930, *Oreolpium* Benedict and Malcolm 1978, *Protogarypinus* Beier 1954, *Teratolpium* Beier 1959 and *Thaumatolpium* Beier 1931) from the Olpiidae to the Garypinidae by Harvey and Štáhlavský (unpublished data), the family now contains 33 genera (Table 1).

Hoff (1945) divided the Olpiinae into the tribes Olpiini Banks 1895 and Xenolpiini Hoff 1945 based upon the morphology of the first pair of legs in which the femur are longer than the patella in Olpiini, with a freely moveable joint, but the two segments are subequal in Xenolpiini, thus allowing only restricted movement. Both tribes were rediagnosed by Hoff (1964), but were subsequently used only intermittently by later researchers. They were abandoned by Heurtault (1980b), who presented new data on the type species of several Old World genera, including the type genera of the two tribes, *Olpium* L. Koch 1873 and *Xenolpium* Chamberlin 1930. In particular, Heurtault (1979, 1980a, 1980b) found

that the type species of *Xenolpium*, *X. pacificum* (With 1907) from New Zealand, possessed leg morphology characteristic of the Olpiini requiring the automatic synonymy of the two tribes. In the meantime, Hoff (1964) included a third tribe – Hesperolpiini Hoff 1964 – within the Olpiinae based upon the long venom ducts within the chelal fingers, and the patella of leg I shorter than the femur, with a freely mobile joint. Hoff (1964) included *Hesperolpium* and *Aphelolpium* within the Hesperolpiini, which was augmented by the inclusion of *Planctolpium* Hoff 1964 by Muchmore (1979), previously described as a member of the Garypidae (Hoff 1964). Long venom ducts are also found in a variety of other olpiids: *Apolpium* Chamberlin 1930 (Chamberlin 1931; Tooren 2002; Harvey, personal observation), *Calocheirus* Chamberlin 1930 (Mahnert 1986, 2002), *Cardiolpium* Mahnert 1986 (Mahnert 1986), *Ectactolpium* Beier 1947 (Harvey, personal observation), *Nanolpium* Beier 1947 (Harvey, personal observation), *Progarypus* Beier 1931 (Mahnert 2001; Harvey,

**Table 1** Genera assigned to the Olpiidae.

Family Olpiidae Banks 1895

Subfamily Olpiinae Banks 1895

*Antilloolpium* Muchmore 1991  
*Austrohorus* Beier 1966  
*Banksolpium* Muchmore 1986  
*Beierolpium* Heurtault 1977  
*Calocheiridius* Beier and Turk 1952  
*Euryolpium* Redikorzev 1938  
*Halominniza* Mahnert 1975  
*Heterolpium* Sivaraman 1980  
*Hoffhorus* Heurtault 1977  
*Horus* Chamberlin 1930  
*Indolpium* Hoff 1945  
*Leptolpium* Tooren 2002  
*Linnacolpium* gen. nov.  
*Minniza* Simon 1881  
*Neopachyolpium* Hoff 1945  
*Nipponogarypus* Morikawa 1955  
*Novohorus* Hoff 1945  
*Olpiolum* Beier 1931  
*Olpium* L. Koch 1873  
*Pachyolpium* Beier 1931  
*Parolpium* Beier 1931  
*Pseudohorus* Beier 1946  
*Xenolpium* Chamberlin 1930

Subfamily Hesperolpiinae Hoff 1964

*Aphelolpium* Hoff 1964  
*Apolpium* Chamberlin 1930  
*Calocheirus* Chamberlin 1930  
*Cardiolpium* Mahnert 1986  
*Ectactolpium* Beier 1947  
*Hesperolpium* Chamberlin 1930  
*Nanolpium* Beier 1947  
*Planctolpium* Hoff 1964  
*Progarypus* Beier 1931  
*Stenolpiodes* Beier 1959  
*Stenolpium* Beier 1955



**Figure 1** *Linnacolpium linnaei* sp. nov., holotype male (WAM T82354).

personal observation), *Stenolpiodes* Beier 1959 (Harvey, personal observation) and *Stenolpium* Beier 1955 (Mahnert 1984; Harvey, personal observation). All of these genera, along with *Aphelolpium*, *Hesperolpium* and *Planctolpium*, are here regarded as hesperolpiines, based upon the criteria explicitly outlined by Hoff (1964).

Although we concur with Heurtault (1979, 1980a, 1980b) that a satisfactory division between the Olpiini and Xenolpiini is unobtainable, we agree with Hoff (1964) that the hesperolpiines appear to represent a distinct diagnosable entity, which is here recognised as a subfamily of the Olpiidae. The proposal by Judson (1992, 1993) that the Hesperolpiinae represents a member of the Garypidae remains untested (but see below). The Hesperolpiinae contains 11 genera, whereas the relimited Olpiinae contains 22 genera (Table 1). Nearly all Olpiinae possess short venom ducts where they generally do not reach *et* in the fixed chelal finger or *t* in the moveable chelal finger. The most obvious exception is *Mimiza barkhamae* Mahnert 1991 from Saudi Arabia, in which the venom ducts are quite elongate (Mahnert 1991). The distinctiveness of the hesperolpiines is further emphasized by the results of Muriene *et al.* (2008) who, using molecular sequence data from two nuclear ribosomal genes and one mitochondrial protein-encoding gene, found that the three hesperolpiines used in the study (*Apolpium parvum* Hoff 1945, *Nanolpium* sp. and *Progarypus* sp.), formed a clade with the olpiine *Pachyolpium* sp., whereas the remaining olpiines (*Beierolpium borneisszai* (Beier 1966), *Calocheiridius termitophilus* Beier 1964, *Euryolpium* sp. and *Xenolpium* sp.) formed a monophyletic clade that was sister to Garypidae (*Anagarypus heatwolei* Muchmore 1982 and *Syusphyronus apimelus* Harvey 1987). This phylogeny was found with the combined analysis of (a) the 18S rRNA, 28S rRNA and COI data, and (b) the 18S rRNA and 28S rRNA data. The COI analysis found Garypidae grouping with *Pachyolpium* sp. and *Apolpium parvum*, with *Nanolpium* sp. and *Progarypus* sp. grouping with the remaining olpiines. The placement of *Pachyolpium* sp. with the hesperolpiines argue against the proposed division of the Olpiidae into two subfamilies, but presumably further molecular markers and additional taxa may help to resolve this conundrum.

Further research into the affinities of both olpiid subfamilies is necessary. The olpiines and hesperolpiines share a number of morphological features with other garypoid families: the short venom ducts found in olpiines are also found in Menthidae and some Garypinidae (all genera except *Amblyolpium* Simon 1898 and *Neoamblyolpium* Hoff 1956), and the long

venom ducts characteristic of the Hesperolpiinae are also found in Geogarypidae, Garypidae, Larcidae and some Garypinidae (*Amblyolpium* and *Neoamblyolpium*). The lack of any features providing firm evidence for the monophyly of the Olpiidae suggests that the Olpiinae and Hesperolpiinae may not be sister taxa, concordant with the analyses of Muriene *et al.* (2008), and that other character systems need to be explored to establish their affinities and status within the Garypoidea.

#### Genus *Linnacolpium* gen. nov.

##### Type species

*Linnacolpium linnaci* sp. nov.

##### Diagnosis

*Linnacolpium* differ from all other olpiid genera by the following combination of characters: two blades in the cheliceral rallum (Figure 8), reduced eyes (Figure 2), the lack of enlarged tactile setae on the dorsal surface of the pedipalpal femur (Figure 3), and the position of trichobothrium *it* which is situated on the externo-dorsal face of the fixed chelal finger (Figure 3). *Linnacolpium* can be explicitly distinguished from other olpiid genera currently known to occur in Australia as follows: from *Beierolpium* by the position of trichobothrium *st*, which is distal to *sb* in *Linnacolpium* and dorsal to *sb* in *Beierolpium* (e.g. Heurtault 1982; Harvey 1988); and from *Euryolpium*, *Olpium* and *Xenolpium* by the position of trichobothrium *est* which is clearly basal to *it* in *Euryolpium*, *Olpium* and *Xenolpium*, but is on approximately the same level as *it* in *Linnacolpium*. There also appears to be unnamed representatives of *ludolpium* in Australia (Štáhlavský *et al.* 2006; Harvey, unpublished data), which can be distinguished by the same criterion as *Euryolpium*, *Olpium* and *Xenolpium*.

##### Description

###### Male

*Chelicera*: with 5 setae on hand, all setae acuminate; movable finger with 1 subdistal seta; subterminal tooth of movable finger not bifurcate and not enlarged; rallum of 2 or 3 blades, anterior blade smooth except for 2 basal serrations on posterior margin; lamina exterior present, quite broad.

*Pedipalp*: femur apparently without tactile setae. Fixed chelal finger with 8 trichobothria, movable chelal finger with 4 trichobothria; *cb*, *esb* and *isb* situated basally in straight row; *cb* and *esb* closely spaced, less than 1 areolar diameter apart, *esb* closer to *isb* than to *cb*; *est* situated medially on external face of fixed finger, situated midway

between *et* and *esb*; *et* situated subdistally; *ist* situated on approximately same level of *isb*; *ib* situated dorsal to *eb*; *st* situated closer to chelal finger margin than *b*, *sb* and *t*. Venom apparatus present in both chelal fingers, venom ducts very short, terminating in nodus ramosus almost immediately.

*Cephalothorax*: carapace sub-rectangular; with 1 pair of eye-spots with very flat lenses situated near anterior margin of carapace.

*Abdomen*: pleural membrane longitudinally striate. Tergites and sternites without any trace of suture line; glandular setae absent. Spiracular helix present.

*Genitalia*: dorsal anterior glands absent; ejaculatory canal atrium large; with 1 pair of internal glandular setae; median genital sac ovoid.

*Legs*: junction between femora and patellae I and II broad and apparently mobile; femur I approximately same length as patella I; tibiae III and IV without tactile seta; metatarsi III and IV with long tactile seta situated very close to basal edge; setal formula of metatarsus IV T-1-1-2-1 or T-1-1-3-1 or T-0-1-1-3 or T-2-2-3-2; arolium much longer than claws, not divided.

### Etymology

This genus is named for Carolus Linnaeus (1707-1778), founder of the modern system of taxonomy during the 250th anniversary of the publication of the 10th edition of *Systema Naturae* (Linnaeus 1758), and combined with the generic name *Olpium*. It is neuter in gender.

### *Linnaeolpium linnaei* sp. nov.

Figures 1-12

### Material examined

#### *Holotype*

**Australia: Western Australia:** ♂, Mesa K (sample K0502 T4-2), near Pannawonica, 21°42'33"S, 116°16'16"E, 12 January 2007, D. Kamien (WAM T82354).

### Diagnosis

*Linnaeolpium linnaei* is distinguished from all other Australasian olpiids by the reduced eyes.

### Description

#### *Adult male*

Body moderately flattened. Colour with sclerotized portions generally very pale, pedipalps and anterior portion of carapace slightly darker.

*Chelicera*: with 5 setae on hand (Figure 6), all setae acuminate; movable finger with 1 subdistal seta; subterminal tooth of movable finger not bifurcate and not enlarged; with 2 lyrifissures on dorsal face and 1 lyrifissure on ventral face; galea with bifurcate tip and 1 sub-medial ramus; rallum composed of 2 blades, distal blade with 2 basal serrations on posterior margin, basal blade smooth (Figure 8); serrula exterior with 16 blades; lamina exterior present, moderately broad.

*Pedipalp*: trochanter, femur and patella completely smooth, chela with several large granulations on mesal surface at base of fingers; setae very long and acicular; trochanter elongate, without tubercles; trochanter 2.73, femur 3.47, patella 2.35, chela (with pedicel) 3.60, chela (without pedicel) 3.50, hand 1.75 times longer than broad, movable finger 1.06 times longer than hand. Femur apparently without long tactile setae. Patella with three lyrifissures situated dorsally near pedicel. Fixed chelal finger with 8 trichobothria, movable chelal finger with 4 trichobothria (Figure 4): *eb* and *esb* situated basally; *esb* closer to *eb* than to *isb*; *est* slightly basal to *it*; trichobothria *ib* situated slightly basally to *eb*; *ist* slightly distal to *isb*; *et* situated near distal end of finger; ca. 6 microsetae (chemosensory setae) present on fixed finger: distal to *et*; *sb* situated closer to *b* than to *st*; *t* situated mid-way between *st* and tip of movable finger; microsetae (chemosensory setae) not present on movable finger; small "sensory spot" situated slightly distal to *sb*, consisting of single elliptical opening. Venom apparatus present in both chelal fingers, venom ducts very short, terminating in nodus ramosus almost immediately. Chelal teeth obtuse; fixed finger with 25 teeth; movable finger with 23 teeth; accessory teeth absent.

*Cephalothorax*: carapace (Figure 2) 1.38 times longer than broad; sub-rectangular; with 1 pair of eye-spots with flat lenses situated near anterior margin of carapace, posterior pair missing; with 16 setae, arranged 4: 4: 2: 4: 2; without furrows; with 5 pairs of lyrifissures. Manducatory process with 1 long distal, 1 long sub-distal and 2 small internal setae; remainder of maxilla with 6 setae. Chaetotaxy of coxae I-IV: 3: 5: 4: 5.

*Abdomen*: pleural membrane longitudinally striate. Tergites and sternites without medial suture. Tergal chaetotaxy: 2: 2: 2: 3: 4: 3: 4: 4: 4: T1T2T1T: 1T2T1: 2; uniseriate; all setae acicular. Sternal chaetotaxy: 6: (0) 2 [1+1] (0): (0) 4 (0): 4: 4: 4: 4: 4: T1T2T1T: 1T1T1T: 2; setae uniseriate and acuminate; glandular setae absent; anus not surrounded by sternite XI.

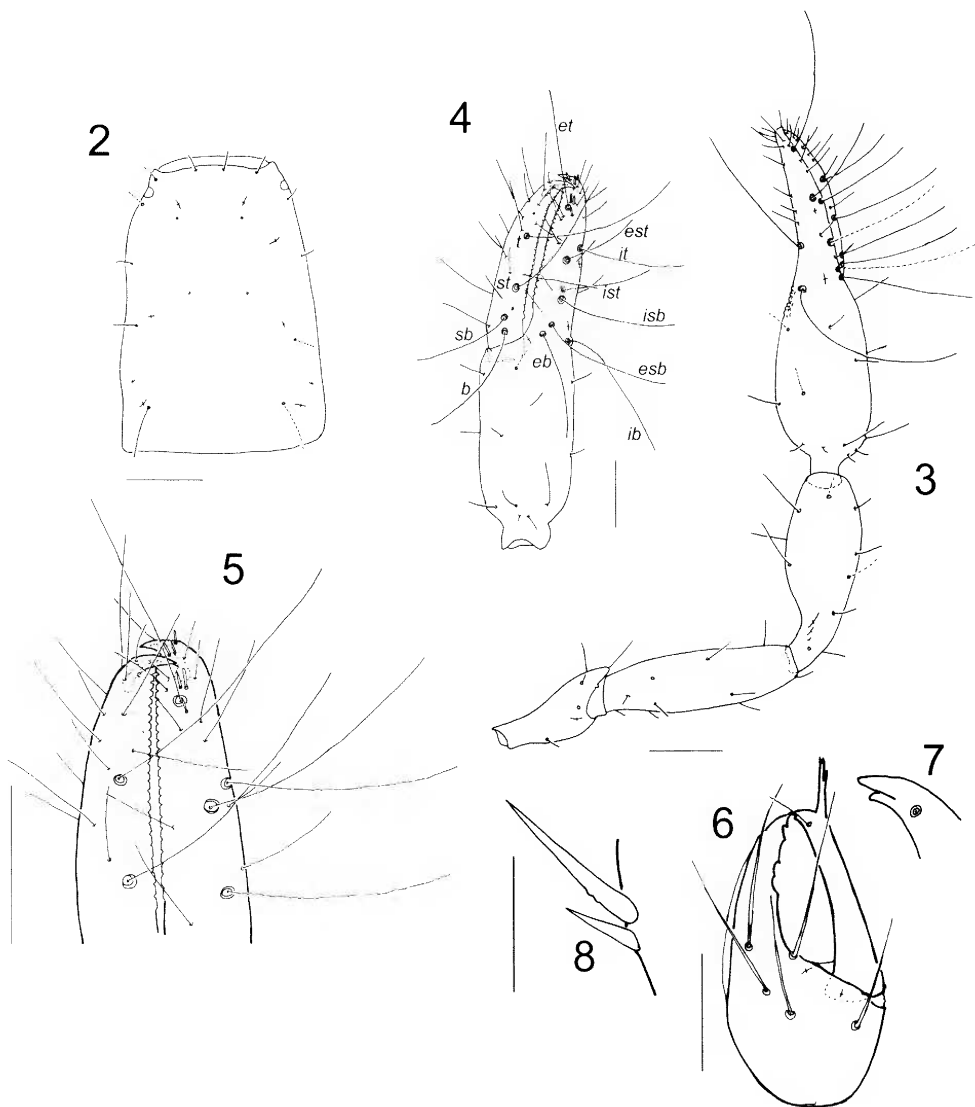
*Genitalia*: ejaculatory canal atrium large and rounded; dorsal anterior glands absent; median genital sac ovoid, undivided (Figure 12).

*Legs*: junction between femora and patellae I and

II broad and apparently sub-mobile; femur I about same length as patella I; femur + patella of leg IV 3.56 times longer than broad; femora I and II with 2 perpendicular lyrifissures situated sub-distally; tibiae III and IV with 2 moderately long tactile setae, one situated proximally, the other situated sub-medially (Figure 10); metatarsi III and IV with long subbasal tactile seta (Figure 10); metatarsus IV with setal formula of T-1-1-2-1 (i.e. dorsal face with 1 tactile seta and 2 regular setae; ventral face with 2 paired setae; lateral face with 1 seta); tarsus IV

with 4 pairs of ventral setae; subterminal tarsal setae arcuate and acute; arolium much longer than claws, not divided (Figures 9-11).

*Dimensions (mm)*: Male holotype: Body length 1.32. Pedipalps: trochanter 0.192/0.070, femur 0.288/0.083, patella 0.250/0.106, chela (with pedicel) 0.461/0.128, chela (without pedicel) 0.448, hand length 0.224, movable finger length 0.237. Chelicera 0.115/0.064, movable finger length 0.090. Carapace 0.176/0.128; eye diameter 0.003. Leg I: femur not



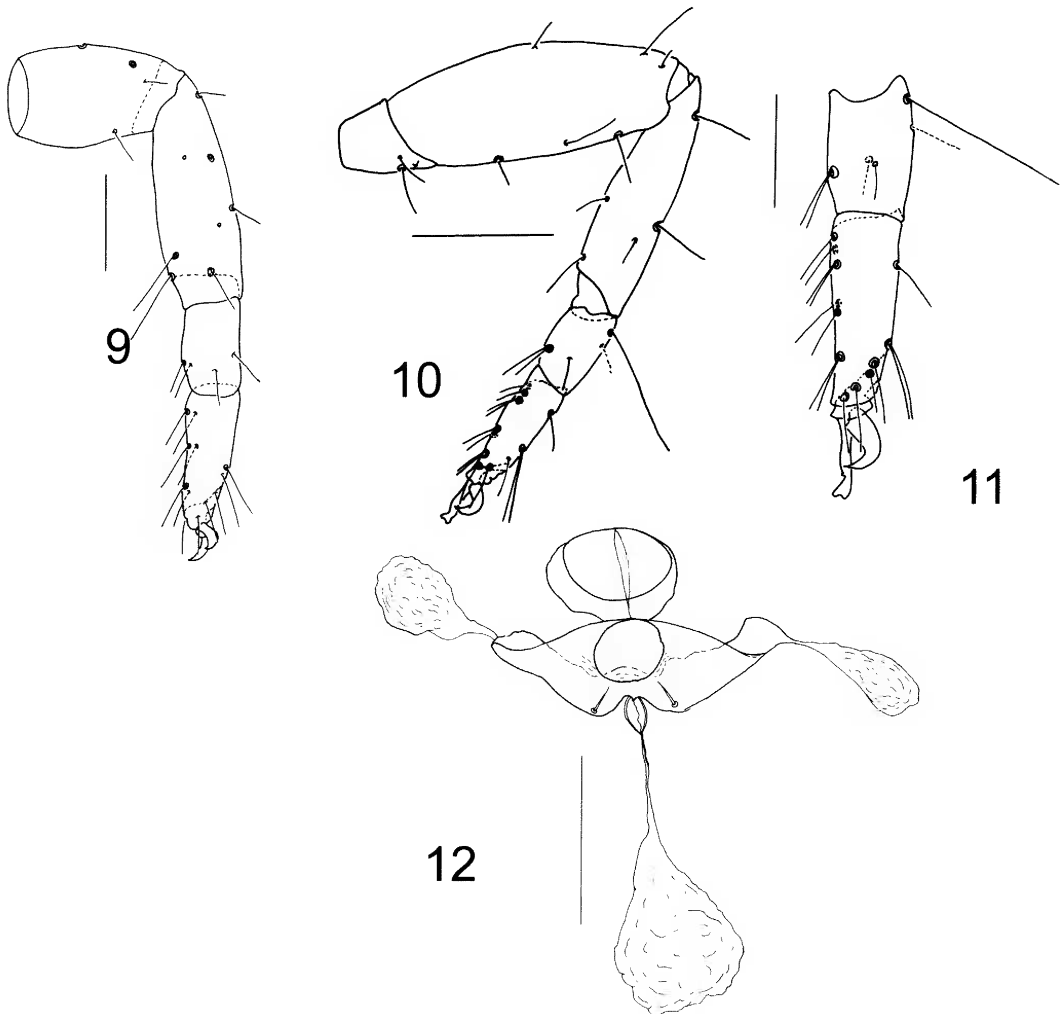
Figures 2-8 *Linnaecolpium linnaei* sp. nov., holotype male (WAM T82354): 2, carapace, dorsal aspect; 3, right pedipalp, dorsal aspect; 4, left chela, lateral aspect; 5, left chelal fingers, detail; 6, right chelicera, dorsal aspect; 7, tip of movable cheliceral finger, dorsal aspect; 8, right rallum, lateral aspect. Scale lines = 0.1 mm (Figures 2-5), 0.5 mm (Figure 6), 0.25 (Figure 8).

measurable, patella 0.180/0.076, tibia 0.255/0.077, metatarsus 0.102/0.061, tarsus 0.128/0.051. Leg IV: femur + patella 0.249/0.070, tibia 0.173/0.047, metatarsus 0.058/0.040, tarsus 0.090/0.031.

#### Remarks

*Linnaeolpium linnaei* is currently known from only a single location in north-western Western Australia where it was taken from a litter trap within a pisolite mesa, and as such can be readily characterised as a short-range endemic species as defined by Harvey (2002). The specimen displays some troglomorphic features such as reduced eyes and pallid colouration. Despite having examined

numerous Australian olpiines from a wide variety of habitats, we have not seen any specimens apart from the holotype of *L. linnaei* that bears reduced eyes. Other troglitic pseudoscorpions have been recently recorded from the pisolitic mesas situated near Pannawonica, including *Tyrannochthonius basme* Edward and Harvey 2008 and *Lagynochthonius asema* Edward and Harvey 2008 (Chthoniidae) (Edward and Harvey 2008), *Indohya* sp. (Hyidae) (Harvey and Volschenk 2007), and *Ideoblothrus pisolitus* Harvey and Edward 2007, *I. linnaei* Harvey and Leng 2008, and *I. sp. Mesa A* (Syarinidae) (Harvey and Edward 2007a; Harvey and Leng 2008). All of these species



Figures 9-12

*Linnaeolpium linnaei* sp. nov., holotype male (WAM T82354): 9, left leg I, patella-tarsus, lateral aspect; 10, left leg IV, lateral aspect; 11, left leg IV, metatarsus and tarsus. Scale lines = 0.1 mm (Figure 10), 0.5 mm (Figures 9, 11), 0.05 (Figure 12).

exhibit troglomorphic morphological features, as do other troglobitic arachnids recorded from the region including an oonopid spider (Harvey and Edward 2007b) and several schizomids (Harvey *et al.* 2008).

### Etymology

This species is named for Carolus Linnaeus (1707-1778).

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